7. IMPACT OF FOOD GROUPS INTAKES ON THE RISK OF COLORECTAL CANCER – 2006–2008 STUDY

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Methods

In the analysis the following food groups were considered: fruit, vegetables, protein-rich products (meats, fish and eggs), grains, milk and dairy products, alcoholic and non-alcoholic drinks.

The detailed description of each food group with rationale for the choice of food items included is provided before description of the results, together with detailed information about food items included into the each analyzed group and subgroup.

The information on food groups obtained from the FFQ-questionnaire were analyzed using two approaches. First one was based on number of portions analysis for main food groups and then for subgroups (included in the analysis). In the Food Frequency Questionnaire the standard portion for each of 148 food products and beverages was defined based on the intake in the population. Respondent could choose half of the standard portion, one, two or three portions eaten at one occasion, and then he/she had to choose frequency of consuming specific food. For the purpose of this analysis the number of portions eaten per week was calculated. For the alcoholic drinks standard portion was defined as a drink which contains 10 g of pure alcohol.

Second approach was based on weight of consumed foods and beverages. The exceptions were alcohol and alcoholic drinks. In this analysis alcohol intake was expressed in grams of pure alcohol from different alcoholic beverages. The following rules were used: beer contains on average 5% of pure alcohol, wine – 10% and vodka – 40%.

Statistical analysis

All variables concerning intake data were used in the analysis as continuous ones. First, we checked normality of data and because distributions of analyzed variables were skewed, we used means and standard deviations as well as medians and quartile deviation to describe dietary patterns of cancer and control groups.

To find statistically significant differences between cases and controls, nonparametric Mann-Whitney test for continuous variables and Chi^2 test for categorical ones were used.

All the statistical analyses were performed using the SPSS v14.0 software. Testing for statistical significance was done on 5% level of significance.

Cereals/Grains

Cereals are defined as the edible seeds of plants, particularly of the grass family (*Gramineace*). Cereal grains are staple crops, grown in greater quantities and provide more energy worldwide than any other type of crop. The most common cultivated grains are wheat, barley, oats and rye in Europe, maize in America, quinoa in South America, rice in the East, and millet in Africa. To this group belong also some food made from grains such as bread, pasta, oatmeal and breakfast cereals. Like all seeds, cereals are highly nutritious because they contain all nutrients the embryo plant needs to start growing. Cereals supply most of their food energy as starch; they are therefore good source of carbohydrates. They also contain great deal of proteins, essential fatty acids, dietary fiber, vitamins such as thiamine, riboflavin, niacin, folate and minerals – iron, magnesium and zinc (1). It is necessary to notice that grain proteins are not complete protein and bioavailability of nutrients is limited due to partial binding with the fiber or phytic acid (2).

Grains and grain foodstuffs are divided in 2 subgroups, made of whole grains and of refined grains.

Whole grains – contain entire grain kernel: the bran, germ, and endosperm; are good sources of dietary fiber, essential fatty acids, vitamins – especially B group and minerals such as iron or magnesium.

Refined grains – as distinct from whole grains, they have been milled. During this process the bran and germ are removed. The process extends durability of cereals foodstuffs, but also removes most of dietary fiber, oil, proteins, iron and most amounts of B vitamins.

In the analysis we used following classification of cereal products:

Group	Foods
Whole grains	Whole grains bread, graham rolls
Refined grains	Refined grains bread, wheat rolls, cereals, pasta, rice, barley, groats, pancakes, dumplings, croquettes

Results

Consumption of cereal products in the study population was high; most of the participants consumed daily more than 10 portions. Whole grains has been eaten only in small proportion (54.2% of population did not eat at all whole grains), most of consumed cereals were refined. Average weekly intake of grains for cases and control group are presented in Tables 7.1 and 7.2. Consumption of total grains, whole and refined grains, expressed both in portion and grams, was similar in the analyzed groups and no statistically significant differences in their intakes were found.

Table 7.1. Mean and median intakes of cereals products for colorectal cancer cases and controls – expressed in number of portions per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Grains – total	Mean	78.29	77.60	
[portions/week]	SD	20.38	19.12	0.418
	Median	77.00	77.00	
	(Q3–Q1)/2	10.50	14.00	
Whole grains	Mean	7.36	7.02	
[portions/week]	SD	9.80	8.92	0.956
	Median	0.00	0.00	
	(Q3–Q1)/2	7.00	7.00	
Refined grains	Mean	70.93	70.58	
[portions/week]	SD	18.09	17.73	0.527
	Median	70.00	70.00	
	(Q3–Q1)/2	52.50	45.50	

Table 7.2. Mean and median intakes of cereals products for colorectal cancer cases and controls – expressed in grams per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Grains – total	Mean	1600.12	1575.35	
[g/week]	SD	605.73	532.76	0.895
	Median	1601.18	1543.01	
	(Q3–Q1)/2	357.18	370.79	
Whole grains	Mean	322.59	285.85	
[g/week]	SD	587.26	496.52	0.930
	Median	0.00	0.00	
	(Q3–Q1)/2	192.33	169.41	
Refined grains	Mean	1277.54	1289.50	
[g/week]	SD	610.49	583.39	0.697
	Median	1232.07	1275.12	
	(Q3–Q1)/2	1323.39	1514.03	

Fruits

The term "fruit," in biology, refers to the mature ovary or ovaries of a seed-bearing plant, including accessory parts, containing the seeds and occurring in a wide variety of forms – berries, pomes, nuts, legumes etc. In cuisine or food science, the term usually refers to those fruits that are fleshy and have a sweet or sour taste, for example apples, bananas, lemons. They are, with the exception of melons, pineapple, strawberry and wild strawberry, fruits of trees and bushes. Dietary guidelines usually account 100% fruit juices to this food group, too. Fruits may be consumed as raw, canned, frozen, or dried and

sometimes are being used to prepare cooked or baked desserts. This food group is reach source of the carbohydrates, especially mono- and disaccharides and many necessary micronutrients, such as provitamins of vitamin A, vitamin C and small amounts of vitamins of B group, potassium, calcium, iron. Fruits also deliver dietary fiber (1, 2). Apart from vitamins and minerals, the fruits contain other bioactive components, for example: flavonoids, flavonols, citric and phenolic acids, sterols (3, 4, 5). All of these substances can have a potential impact on human health (6, 7, 8, 9). Based on botanical classification, fruits can be divided into several groups:

Berries:
- True berries: currants (black, red), kiwi fruit, grape
- Pepo: various types of melons
- Hesperidium – most citrus fruits, like orange or grapefruit

False berries: banana, cranberry

Compound fruits:
- Aggregate fruits: blackberry, raspberry
- Multiple fruits: pineapple, fig

Other accessory fruits:
- Pomes: apple, pear
- Stone fruits: plum, cherry, apricot
- others

But food sciences and commerce usually distinguish only four groups, not necessarily being consistent with botanical classification: berries, citruses, stone fruits and other fruits.

Berries – perishable fruits of bushes or herbaceous plants, which are characterized by soft, juicy flesh with a lot of small seeds. This group includes also blackberries, raspberries and strawberries, although botanically they are not the berries.

Citruses – fruits of evergreen trees or tall shrubs; type of berries with a tough, leathery rind, with high amount of juice and several seeds, such as lemon, orange, grapefruits, mandarin. Citruses contains large amount of vitamin, especially vitamin C.

Stone fruits – fruits with one woody stone within, for example cherry, plum, peach.

Other fruits – different fruits not mentioned above, such as apples, pears, bananas and others.

For the purpose of this analysis we used the second classification. Because apples are the most common fruits eaten in Poland, they were separated from "other fruits" into individual subgroup.

Group	Foods
Apples	
Berries	Grapes, strawberries, black and red currants, raspberries, Bilberries, blackberries
Citruses and kiwi fruit	Oranges, grapefruits, mandarin oranges, kiwi fruits
Stone fruits	Peaches, nectarines, cherries, plums
Other fruits	Pears, bananas

Results

Consumption of fruits in the study population was low, standard intake did not exceed one fruit a day. Most frequently consumed were apples – usually more than 3 portions weekly, most rarely stone fruits. Average weekly intake of total fruits, apples, berries, citruses, stone fruits and others are presented in the Table 7.3. Median consumption of all fruits and their subgroups, except berries, reported by cases was lower than in controls, but observed differences were not statistically significant. Similarly mass of consumed fruits was lower in cases group, but without statistically significant difference (Table 7.4).

Table 7.3. Mean and median intakes of fruits for colorectal cancer cases and controls – expressed in number of portions per week (2006–2008)

Intakes		**Cases N = 185**	**Controls N = 204**	**p value for Mann-Whitney test**
Fruits – total	Mean	7.29	8.00	
[portions/week]	SD	4.98	5.88	0.342
	Median	6.92	7.00	
	(Q3–Q1)/2	1.14	2.90	
Apples	Mean	4.06	4.73	
[portions/week]	SD	3.85	4.90	0.285
	Median	3.00	3.75	
	(Q3–Q1)/2	0.85	2.12	
Berries	Mean	1.27	1.34	
[portions/week]	SD	1.56	1.97	0.819
	Median	0.84	0.80	
	(Q3–Q1)/2	0.32	0.83	
Citrus fruits	Mean	0.84	0.87	
[portions/week]	SD	1.23	0.94	0.352
	Median	0.57	0.78	
	(Q3–Q1)/2	6.38	2.37	
Stone fruits	Mean	0.47	0.48	
[portions/week]	SD	0.55	0.53	0.739
	Median	0.34	0.42	
	(Q3–Q1)/2	0.14	0.39	
Other fruits	Mean	0.87	0.90	
[portions/week]	SD	0.80	0.96	0.943
	Median	0.78	0.78	
	(Q3–Q1)/2	0.21	0.61	

Table 7.4. Mean and median intakes of fruits for colorectal cancer cases and controls – expressed in grams per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Fruits – total	Mean	327.51	355.50	
[g/week]	SD	236.32	272.14	0.510
	Median	306.22	320.48	
	(Q3–Q1)/2	46.61	125.20	
Apples	Mean	180.18	207.22	
[g/week]	SD	181.59	224.55	0.277
	Median	143.54	149.91	
	(Q3–Q1)/2	34.09	79.75	
Berries	Mean	52.90	55.64	
[g/week]	SD	59.59	68.82	0.839
	Median	36.96	41.55	
	(Q3–Q1)/2	13.14	33.23	
Citrus fruits	Mean	26.05	23.10	
[g/week]	SD	35.84	25.00	0.817
	Median	16.73	18.48	
	(Q3–Q1)/2	128.68	71.80	
Stone fruits	Mean	29.55	30.82	
[g/week]	SD	35.80	35.43	0.435
	Median	19.18	24.96	
	(Q3–Q1)/2	8.47	22.93	
Other fruits	Mean	38.82	38.72	
[g/week]	SD	36.42	38.29	0.973
	Median	31.29	35.39	
	(Q3–Q1)/2	9.15	25.67	

Vegetables

The term "vegetable" is a commonly used name of any herbaceous plants cultivated for their edible parts. Variety of the parts of plants are used as food, for example roots of carrot or beet; tubers of potato, bulbs of onion, stems of asparagus; leaves or stalk of leaves – lettuce or rhubarb; fruits of tomato, seeds of bean plants and even flower buds like broccoli or cauliflower. Also mushrooms, though belonging to the biological kingdom Fungi, are rated among this group, too. The group does not include cereal grains, nuts, oily seeds, herbs and spices.

Vegetables can be consumed in different forms. Some of them, such as lettuce, cucumber are consumed usually as raw, another are eaten either raw or cooked – carrot, cabbage, while others, such as potato or eggplant are traditionally eaten only when cooked and some of them can be pickled – cucumber, cabbage. Usually they are eaten along with a main dish, in mixed dishes, as an appetizer or in salads, it means in savory or salted dishes.

The nutritional content of vegetables varies considerably in the different subgroups. Most of them are naturally low in fat and proteins but are important sources of carbohydrates, dietary fiber and many micronutrients, mainly potassium, folates, provitamins of vitamin A, vitamin E and vitamin C (1, 2). Other bioactive compounds, such as flavonoids, terpens, salicylates, and phenols, although not included into nutrients, can play very important role in human health (10, 11). Diet rich in vegetables and fruits is a part of an overall healthy lifestyle and may reduce risk for many diseases, for example, mouth, stomach, and colon cancers, coronary heart disease, stroke, and diabetes (12, 13, 14, 15, 16, 17). Because vegetables are low in calories (with few exceptions, such as avocado or groundnuts) comparing to other kinds of food, they may be useful to maintain proper energy balance and prevent overweight and obesity.

There are few different classifications of vegetables groups. They have been categorized according to: color, edible parts, processing and preparation manner, main nutrients content or botanical classifications:

Color:

- Dark green vegetables – owe their name to large amount of chlorophyll, the green pigment containing iron. They have also large amount of folacin, beta-carotene, magnesium and calcium. The two general uses for this group of vegetables are salad crops, which are eaten raw, and potherbs, which are usually cooked prior to eating.
  This group includes: broccoli, spinach, dark green leafy lettuces, kale and watercress, etc.
- Deep yellow and orange vegetables – especially reach source of carotenoids; the greater the intensity of the color of the vegetable, the more beta-carotene it contains.
  Include: carrots, pumpkin, various kind of squash.
- Pale or white vegetables – incorporate a wide range of white, pale green or light green vegetables – usually contain high amount of water and low contents of other nutrients, but most of them are good source of phytochemicals, some vitamins and minerals.
  Include: celery, onion, leek, chicory, cucumber, cauliflower, turnip, cabbage and button mushrooms.

Edible parts:

- Green leafy vegetables:
  Include: spinach, lettuce, chicory, cabbage.
- Dry beans and peas – the mature seeds of legumes. They are a rich source of plant proteins and can be treated as vegetarian alternatives for meat. Legumes have also substantial amount of fiber, zinc, iron, folates and isoflavones.
  Include: white, black and other kind of beans, lentils, soy beans and tofu (bean curd made from soybeans), black-eyed and other mature kind of peas.
- Root vegetables:
  Include: carrots, parsley-root, beetroot.
- Fruiting vegetables:
  Include: tomato, cucumber, sweet pepper, eggplant.

Main nutrients contents:

- Starchy vegetables – include seeds or tubers of crops, which the chief food store is starch. To this group belong potatoes, corn and green peas, eaten exclusively after thermal processing.
- Dry beans and peas.
- Dark green vegetables.
- Deep yellow and orange vegetables.

Botanical classification:

- *Cruciferous* vegetables (cabbages) – edible plants from *Brassicaceae* family, one of the dominant food crops worldwide. The group is a rich source of vitamin C, folate, potassium, selenium, fiber, as well as antioxidants: flavonoids, carotenoids, lingnans, phytosterols, isothiocyanates, sulforaphane and glucosinolates, important for human health.
  Include: cabbage, red cabbage, Brussels sprouts, broccoli, cauliflower, turnip, horseradish.
- *Solanaceae* vegetables – tomatoes and tomato's preserves, such as tomato sauce, ketchup, tomato juice and sweet pepper. Most important component in this group is lycopene – the bright red carotenoid pigment, but they contain also high amount of β-carotene and vitamin C. Also potatoes, although not always included in vegetables group, belong to *Solanaceae* family.
- *Liliaceae* vegetables – especially *Allium* species, contain chemical compounds (mostly cystein sulfoxide) that give them a characteristic piquant taste and odor, hence consumed usually in small amount. Chopping garlic releases alliinase, the enzyme promoting the formation of allicin, which has potential antibacterial and anti-fungal properties.
  Include: onion, leek, chives, garlic.
- *Apiaceae* vegetables – very large family, includes above 3000 species, but relatively small amount are used in cuisine. Some of them are cultivated for their roots, some for aromatic leaves and used as used as fully flavored herbs.
  Include: carrot, parsley, celery, parsnip, coriander, dill, fennel.
- *Cucurbitaceae* vegetables – usually fruits and sometimes flower plants of this group are used in cuisine. They contain large amount of water and are not rich in other nutrients.
  Include: cucumber, variety of squashes, among others pumpkin, zucchini; another species are consumed as fruits, such as melons or watermelon.

Processing and preparation manner:

- Raw vegetables – often termed "salad vegetables," have higher amounts of nutrients. The group includes all vegetables eaten without any thermal processing.
- Processed vegetables – some of vegetables, such as legumes or potatoes, can be eaten exclusively after processing, others can be eaten either cooked or raw, but this group includes only vegetables that are consumed after thermal processing. Most forms of cooking reduce the total nutrients amount, but on the other hand cooking can also increase the bioavailability of some nutrients, for example, lycopene.

- Pickled vegetables – fermented with salt or salted water until get sour, such as cabbage or cucumbers. This process changes also nutritional content or bioavailability of vitamins: pickled vegetables have higher amount of thiamine, riboflavin, niacin and vitamin C than the raw ones.

In this analysis we used different classifications – due to processing and preparation manner and main nutrient contents.

Group	**Foods**
Vegetables – total	All type of vegetables mentioned below, except potatoes
Raw vegetables – all	All vegetables consumed without any thermal processing
lettuce	
cabbages, cucumber, radish	
carrot	
tomato, sweet pepper	
onion, chives	
mixed salads	
Processed vegetables – all	Vegetables consumed after thermal processing (cooked, stewed etc.)
cruciferous vegetables	Cabbage, cauliflower, Brussels sprout
other vegetables	Carrot, beet, spinach, salad made of cooked vegetables, string bean, green peas, vegetables soups
Mushrooms	
Pickled vegetables	Pickled cabbage, cucumber and other vegetables
Potatoes and potatoes dishes	Cooked or fried potatoes, crisps, puree, dumplings

Results

Median intake of vegetables in study population was about 11 portions per week in both groups; mainly they were row vegetables, more than 5 portions/week on average (Table 7.5). Cases had a little higher median intake of onion and chives and mixed salads (0.11 vs. 0.06 portions/week and 0.50 vs. 0.11 portions/week, respectively, in cases and controls) and also mushrooms and potatoes, but observed differences were not statistically significant. Taking into account weight of consumed vegetables, we observed a little greater intake of row vegetables in control group – Table 7.6. However, cases consumed more cruciferous vegetables, mushrooms, pickled vegetables and potatoes, but any of these differences were statistically significant.

Table 7.5. Mean and median intakes of vegetables for colorectal cancer cases and controls – expressed in number of portions per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Vegetables – total	Mean	11.72	11.39	
[portions/week]	SD	5.64	4.61	0.918
	Median	10.93	10.98	
	(Q3–Q1)/2	1.24	3.06	
Raw vegetables – total	Mean	6.55	6.31	
[portions/week]	SD	4.12	3.58	0.983
	Median	5.75	5.71	
	(Q3–Q1)/2	0.91	2.19	
lettuce	Mean	0.41	0.50	
[portions/week]	SD	0.72	0.90	0.603
	Median	0.11	0.11	
	(Q3–Q1)/2	0.11	0.50	
cabbages, cucumber,	Mean	0.85	0.91	
radish	SD	0.66	0.71	0.531
[portions/week]	Median	1.00	1.00	
	(Q3–Q1)/2	0.12	0.28	
carrot	Mean	0.65	0.55	
[portions/week]	SD	0.82	0.49	0.343
	Median	0.57	0.57	
	(Q3–Q1)/2	0.18	0.44	
tomatoes, sweet	Mean	3.79	3.56	
pepper	SD	2.82	2.39	0.491
[portions/week]	Median	3.50	3.50	
	(Q3–Q1)/2	0.65	1.18	
onion, chives	Mean	0.37	0.37	
[portions/week]	SD	0.54	0.65	0.444
	Median	0.11	0.06	
	(Q3–Q1)/2	0.11	0.25	
mixed salads	Mean	0.48	0.43	
[portions/week]	SD	0.70	0.56	0.512
	Median	0.50	0.11	
	(Q3–Q1)/2	0.20	0.28	
Processed vegetables – total	Mean	3.46	3.48	
[portions/week]	SD	1.95	1.70	0.478
	Median	3.02	3.15	
	(Q3–Q1)/2	0.43	1.07	
cruciferous vegetables	Mean	1.20	1.15	
[portions/week]	SD	0.94	0.98	0.653
	Median	1.13	1.13	
	(Q3–Q1)/2	0.23	0.68	

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
other vegetables	Mean	2.26	2.33	
[portions/week]	SD	1.43	1.13	0.192
	Median	2.19	2.23	
	(Q3–Q1)/2	0.27	0.73	
Mushrooms	Mean	0.22	0.19	
[portions/week]	SD	0.37	0.45	0.153
	Median	0.11	0.06	
	(Q3–Q1)/2	0.04	0.06	
Pickled vegetables	Mean	1.49	1.41	
[portions/week]	SD	1.69	1.30	0.794
	Median	1.13	1.13	
	(Q3–Q1)/2	0.29	0.72	
Potatoes and potatoes	Mean	10.75	10.33	
dishes	SD	5.73	6.66	0.129
[portions/week]	Median	10.33	10.00	
	(Q3–Q1)/2	1.54	3.91	

Table 7.6. Mean and median intakes of vegetables for colorectal cancer cases and controls – expressed in grams per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Vegetables – total	Mean	599.33	619.00	
[g/week]	SD	249.34	298.21	0.627
	Median	564.83	567.67	
	(Q3–Q1)/2	56.26	131.01	
Raw vegetables – total	Mean	230.93	243.79	
[g/week]	SD	130.21	138.02	0.288
	Median	213.08	213.13	
	(Q3–Q1)/2	31.75	84.58	
lettuce	Mean	9.98	13.86	
[g/week]	SD	16.49	28.10	0.311
	Median	2.52	2.73	
	(Q3–Q1)/2	3.33	10.10	
cabbages, cucumber,	Mean	19.28	23.45	
radish	SD	19.09	22.41	0.099
[g/week]	Median	17.57	20.34	
	(Q3–Q1)/2	6.03	16.87	
carrot	Mean	28.32	27.54	
[g/week]	SD	33.56	24.90	0.816
	Median	24.01	24.50	
	(Q3–Q1)/2	6.84	18.44	

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
tomatoes, sweet	Mean	118.87	122.50	
pepper	SD	72.68	77.54	0.828
[g/week]	Median	107.21	103.67	
	(Q3–Q1)/2	16.65	46.95	
onion, chives	Mean	2.96	3.11	
[g/week]	SD	2.37	2.75	0.695
	Median	2.52	2.59	
	(Q3–Q1)/2	0.60	1.74	
mixed salads	Mean	51.53	53.33	
[g/week]	SD	44.10	49.20	0.774
	Median	41.37	43.54	
	(Q3–Q1)/2	8.62	27.02	
Processed vegetables – total	Mean	278.72	288.07	
[g/week]	SD	148.03	225.69	0.884
	Median	245.91	247.98	
	(Q3–Q1)/2	31.54	85.09	
cruciferous vegetables	Mean	137.85	132.48	
[g/week]	SD	100.41	111.46	0.272
	Median	131.74	118.86	
	(Q3–Q1)/2	25.71	62.82	
other vegetables	Mean	140.87	155.59	
[g/week]	SD	87.80	159.50	0.381
	Median	123.62	137.55	
	(Q3–Q1)/2	19.41	51.49	
Mushrooms	Mean	11.00	8.83	
[g/week]	SD	16.15	16.92	0.098
	Median	4.13	1.89	
	(Q3–Q1)/2	3.16	5.11	
Pickled vegetables	Mean	78.67	78.32	
[g/week]	SD	79.28	81.72	0.824
	Median	70.56	63.53	
	(Q3–Q1)/2	15.30	37.91	
Potatoes and potatoes	Mean	633.33	612.22	
dishes	SD	259.10	277.43	0.114
[g/week]	Median	611.24	579.29	
	(Q3–Q1)/2	56.41	140.56	

Protein-rich products

This group includes all foods of animal origin made from flesh meat, fish or eggs. These foodstuffs are main source of proteins in human diet, especially important for their contents of the essential amino acids. Meat is also a good source of minerals and vitamins, such as iron, copper, zinc, and vitamins group B (1, 2). It is one of the main sources of

vitamin B_{12}, which is only found in animal food, such as meat and milk. Meat, particularly red meat, tends also to be high in fat. The fat content of meat varies depending on the species and breed of animal, the anatomical part of the body, and the methods of preparing. Animal foodstuffs are one of the only dietary sources of saturated fatty acids and cholesterol. Some of the types of the processing and preparation manner can increase content of undesirable substances. During the cooking process heterocyclic amines are created, while processed meat and fish have additional large amount of sodium but also fillers, preservatives, flavor additives and others (18, 19, 20, 21, 22).

Red meat – includes beef, veal, pork, lamb and other type of meats from skeletal muscles, rich in myoglobin - the protein contain a heme group, responsible for the red color of this kind of meat.

Poultry – includes all farm birds, such as hens, ducks, and turkey. This kind of meat contains less myoglobin, its color is much lighter and hence is usually called white meat.

Organ meat – giblets, liver, heart and other types of meat of internal organs origin are particularly high in cholesterol, but are also rich source of vitamins dissolved in fat, such as A, D, K.

Fish – this group includes fish and shellfish, such as mollusks and crustaceans. Some fish (such as salmon, trout, and herring) are high in polyunsaturated fatty acids – omega-3 fatty acids, very important in human diet. On the other hand fish products have been shown to contain various amounts of heavy metals, particularly mercury and fat-soluble pollutants from contaminated water.

Eggs – include eggs of all farm birds and dishes made of these. Egg contains all substances needed for growth and development of bird's embryo. More than half the calories found in eggs come from the fat in the yolk, although only 27% of it is saturated fat that contains cholesterol. Eggs are also the richest source of choline in human diet.

In the analysis we used double classification of protein reach products, based on origin as well as on processing and preparation manner:

Group	Foods
Based on origin:	
red meat	beef, veal, pork, lamb
poultry and rabbit	chicken, turkey, duck, rabbit
organ meat	liver, kidney, heart, lungs
fish	
eggs	cooked, fried, scrambled eggs, omelettes
Based of processing and preparation manner:	
cooked or stewed	various kind of meat consumed as cooked or stewed
fired, roasted or grilled	steak, chop, cutlet, roast, hamburger, grilled sausages
processed meat	ham, sausages, salami, bacon
fired, roasted or grilled fish	all type of fish consumed after thermal processing
processed fish	smoked, pickled or canned fish
offal, giblets, pate, headcheese	

Results

Analysis of meat and meat products intake showed that cases consumed weekly about 19.22 portions of different meats and meat products and controls 17.15 portions ($p = 0.022$). Among the cases we observed higher intake of red meat portions (4.72) than in controls (3.63). There were no statistically significant differences in intake of poultry between the study groups. The analysis of organ meats consumption showed that less than 50% of the study population declared this consumption, but mean intake was higher in the cases (0.31 vs. 0.26 portions in controls) – this result was statistically significant (Table 7.7).

In addition to the weight of eaten meats number of grams per week was also analyzed. Analysis showed higher median intake of meats (including sausages and organ meats) among the cases (1190.49 g/week) than in controls (1073.28 g/week), however, this difference was statistically insignificant (Table 7.8). From different meats (classification based on origin) cases consumed more red meats (287.07 g/week vs. 248.78 g/week in controls; $p = 0.013$). Median consumption of organ meats was 0 g/week in both groups, but mean intake was higher in cases (18.89 g/week) as compared with controls (17.96 g/week) and the difference between the study groups was statistically significant. We did not observe any significant differences between cases and control group in relation to intake of meats with respect to processing and preparation method (cooked, roasted, processed meats) – the results are presented in Table 7.8.

Fish

Analysis of the number of fish portions showed no significant differences in total fish consumption and in consumption of fried/grilled and processed fish (Table 7.7).

Median fish intake per week was slightly lower in the cases than among controls (109.27 g/week vs. 115.01 g/week), but statistically insignificant (Table 7.8). There were also no significant differences between study groups in consumption of fried/grilled and processed fish (in grams per week) – Table 7.8.

Eggs

Median number of egg's portions eaten weekly for cases was 3.14 portions/week and for controls 2.42 portions. This difference was statistically significant ($p = 0.002$) – Table 7.7.

Median consumption of eggs in grams per week was also significantly higher among the colorectal cancer cases (202.93 g/week) than in the control group (138.39 g/week) – Table 7.8.

Table 7.7. Mean and median intakes of protein reach products for colorectal cancer cases and controls expressed in number of portions per week – classification based on origin (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Based on origin:				
Meat – total	Mean	22.22	19.96	
[portions/week]	SD	13.46	13.32	0.022
	Median	19.22	17.15	
	(Q3–Q1)/2	2.91	5.92	
red meat	Mean	5.01	4.36	
[portions/week]	SD	3.20	3.46	0.015
	Median	4.72	3.63	
	(Q3–Q1)/2	0.88	2.25	
poultry and rabbit	Mean	4.69	4.70	
[portions/week]	SD	2.85	2.92	0.953
	Median	4.00	4.00	
	(Q3–Q1)/2	7.50	7.50	
organ meat	Mean	0.31	0.26	
[portions/week]	SD	0.63	0.54	0.023
	Median	0.00	0.00	
	(Q3–Q1)/2	0.07	0.11	
Fish	Mean	1.56	1.55	
[portions/week]	SD	1.51	1.26	0.746
	Median	1.13	1.25	
	(Q3–Q1)/2	0.36	0.77	
Eggs	Mean	3.53	2.87	
[portions/week]	SD	2.49	2.12	0.002
	Median	3.14	2.42	
	(Q3–Q1)/2	0.57	1.44	
Based of processing and preparation manner:				
cooked or stewed meat	Mean	3.42	3.24	
[portions/week]	SD	2.40	2.28	0.498
	Median	2.49	2.45	
	(Q3–Q1)/2	0.60	1.55	
fried, roasted or grilled	Mean	6.56	6.06	
meat	SD	3.60	3.84	0.120
[portions/week]	Median	5.96	5.90	
	(Q3–Q1)/2	1.05	2.60	
processed meat	Mean	11.03	9.81	
[portions/week]	SD	10.44	9.76	0.057
	Median	8.06	7.14	
	(Q3–Q1)/2	1.71	3.18	

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
fried or grilled fish	Mean	1.14	1.17	
[portions/week]	SD	1.18	1.13	0.817
	Median	1.13	1.13	
	(Q3–Q1)/2	0.36	0.89	
processed fish	Mean	0.42	0.38	
[portions/week]	SD	0.61	0.52	0.498
	Median	0.11	0.11	
	(Q3–Q1)/2	0.11	0.28	
offal, giblets, pate,	Mean	1.22	0.86	
headcheese	SD	1.76	1.38	0.001
[portions/week]	Median	0.79	0.45	
	(Q3–Q1)/2	0.27	0.57	

Table 7.8. Mean and median intakes of protein reach products for colorectal cancer cases and controls expressed in grams per week – classification based on origin (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Based on origin:				
Meat – total	Mean	1271.11	1247.28	
[g/week]	SD	578.74	764.09	0.147
	Median	1190.49	1073.28	
	(Q3–Q1)/2	116.17	316.19	
red meat	Mean	309.84	297.25	
[g/week]	SD	188.76	347.11	0.013
	Median	287.07	248.78	
	(Q3–Q1)/2	52.96	125.83	
poultry and rabbit	Mean	392.86	423.03	
[g/week]	SD	202.47	326.41	0.897
	Median	357.07	355.43	
	(Q3–Q1)/2	559.76	1365.00	
organ meat	Mean	18.89	17.96	
[g/week]	SD	30.08	43.92	0.022
	Median	0.00	0.00	
	(Q3–Q1)/2	3.79	8.28	
Fish	Mean	145.23	143.76	
[g/week]	SD	138.44	113.22	0.729
	Median	109.27	115.01	
	(Q3–Q1)/2	34.90	71.33	
Eggs	Mean	216.36	176.48	
[g/week]	SD	155.97	133.29	0.002
	Median	202.93	138.39	
	(Q3–Q1)/2	32.52	84.83	

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Based on processing and preparation manner:				
cooked or stewed meat	Mean	224.54	229.43	
[g/week]	SD	142.40	193.78	0.465
	Median	204.05	192.29	
	(Q3–Q1)/2	27.24	81.12	
fried, roasted or grilled	Mean	520.62	525.73	
meat	SD	256.60	483.76	0.133
[g/week]	Median	474.11	455.07	
	(Q3–Q1)/2	66.32	177.38	
processed meat	Mean	476.34	454.07	
[g/week]	SD	438.96	366.26	
	Median	323.47	334.50	0.840
	(Q3–Q1)/2	64.21	167.01	
fried or grilled fish	Mean	102.82	105.18	
[g/week]	SD	104.95	98.54	0.814
	Median	103.53	103.53	
	(Q3–Q1)/2	31.75	79.38	
processed fish	Mean	42.41	38.57	
[g/week]	SD	60.84	51.98	0.498
	Median	11.48	11.48	
	(Q3–Q1)/2	11.51	28.77	
offal, giblets, pate,	Mean	49.61	38.05	
headcheese	SD	57.07	60.90	0.001
[g/week]	Median	28.63	16.21	
	(Q3–Q1)/2	13.44	26.48	

Milk and dairy products

Dairy products are generally defined as a foodstuffs produced from milk. In Poland most widespread milk comes from cows, but occasionally from sheep or goats. Around the world also other farm animals supply milk, such as camels, zebu cows, yaks, or horses. Because milk is produced by mammal to suckle their young, it contains all the nutrients needed to growth and development infants. Milk and dairy products made of whole milk are rich in protein and fat and low in carbohydrates; contain only disaccharides, especially lactose. They also contain a number of vitamins, including retinol and carotene, vitamin E, D and vitamins group B – apart from meat it is the main source of vitamin B_{12} (1, 2). Dairy products are main source of well absorbed calcium in human diet but also include other minerals such as potassium, phosphorus, magnesium. Low-fat dairy products have reduced energy value due to lower fat content, and also significantly reduced amount of fat soluble vitamins. Some dairy products, for example yogurt, quark, are made through cheese, lactic acid fermentation of milk; other ones, such as acidification

and enzymatic coagulation. Some cheese types also contain molds, either on the outer rind or throughout. Fermented dairy products contain live and active cultures of bacteria, especially of genus *Lactobacillus* or *Bifidobacterium,* that have beneficial effect for health (23, 24, 25).

In the dairy products group we include also fat used with bread, because most of the population used butter to this end.

In the analysis we used following classification of dairy products:

Group	Foods
Milk and milk beverages	Milk, cocoa
Cheese	All type of cheese, quark, curd
Yogurt	All types of yogurts, kefir, sour milk
Ice cream	
Fat used with bread	Butter, margarine

Results

Analysis of weekly consumption of milk and dairy products among colorectal cancer cases and controls showed no statistically significant differences between the study groups (Table 7.9). Cases consumed weekly more portions of all dairy products together (17.31 vs. 16.50 portions/week) and more cheese/cottage cheese portions (11.56 vs. 11.09 portions/week) – but without statistically significant differences (Table 7.9).

The results of the analysis of weight of dairy products consumed per week showed the opposite direction: median intake of all dairy products (expressed as grams per week) was slightly lower among the cases (884.87 g/week) than in control group (969.34 g/week) as well as for cheese/cottage cheese intake (141.82 g/week vs. 154.18 g/week, respectively), but none of these differences were statistically important (Table 7.10).

Table 7.9. Mean and median intakes of dairy products for colorectal cases and controls expressed in grams per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Dairy products – total	Mean	17.54	17.10	
[portions/week]	SD	8.67	7.31	0.653
	Median	17.31	16.50	
	(Q3–Q1)/2	4.31	4.76	
Milk and milk	Mean	3.22	2.74	
beverages	SD	4.73	3.65	0.764
[portions/week]	Median	1.00	1.00	
	(Q3–Q1)/2	3.50	2.50	
Cheese, cottage	Mean	10.99	11.03	
cheese	SD	4.59	4.13	0.677
[portions/week]	Median	11.56	11.09	
	(Q3–Q1)/2	11.09	11.78	

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Yogurt	Mean	3.07	3.13	
[portions/week]	SD	3.35	2.97	0.628
	Median	2.50	2.50	
	(Q3–Q1)/2	2.22	2.00	
Ice cram	Mean	0.25	0.20	
[portions/week]	SD	0.90	0.45	0.455
	Median	0.00	0.00	
	(Q3–Q1)/2	0.06	0.11	
Fat used for bread	Mean	18.04	16.96	
[portions/week]	SD	10.88	10.55	0.337
	Median	14.00	14.00	
	(Q3–Q1)/2	7.00	10.50	

Table 7.10. Mean and median intakes of dairy products for colorectal cases and controls expressed in grams per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Dairy products – total	Mean	1114.47	1078.75	
[g/week]	SD	968.05	771.63	0.565
	Median	884.87	969.34	
	(Q3–Q1)/2	587.44	454.70	
Milk and milk	Mean	483.19	410.34	
beverages	SD	709.86	547.74	0.771
[g/week]	Median	149.59	149.59	
	(Q3–Q1)/2	525.00	373.94	
Cheese, cottage	Mean	178.04	197.65	
cheese	SD	171.36	162.41	0.169
[g/week]	Median	141.82	154.18	
	(Q3–Q1)/2	886.69	506.94	
Yogurt	Mean	444.35	463.61	
[g/week]	SD	504.19	444.70	0.425
	Median	373.94	373.94	
	(Q3–Q1)/2	333.70	322.91	
Ice cram	Mean	8.90	7.14	
[g/week]	SD	31.61	15.96	0.455
	Median	0.00	0.00	
	(Q3–Q1)/2	2.03	4.03	
Fat used for bread	Mean	90.17	84.79	
[g/week]	SD	54.43	52.78	0.337
	Median	70.00	70.00	
	(Q3–Q1)/2	35.00	52.50	

Alcohol and coffee and tea

Alcoholic beverages

Ethanol is one of the final products of sugars' alcoholic fermentation. Many plants and some of animal foods can be used for alcohol production. Usually fruit juices, germinated cereal grains, hydrolyzed starch or other plants containing fermentable sugars are substrates for this process. Most people consume alcohol in the form of a beverage such as beer, wine or spirits. They differ in ethanol content, from 3%–5% for beer up to 40% or more for spirits and liquors. Alcoholic beverages are caloric (1 g of pure alcohol delivers 7 kcal), but contain any or only small amount of other nutrients. Depending on substrates used during fermentation process, they may include also polyphenolic compounds, such as anthocyanins, catechins, tannins and others. Effect of alcohol consumption for human health depends on consumption pattern. The low to moderate consumption is associated with a beneficial effect such as decreased risk of some cardiovascular diseases (26, 27, 28), but abuse of alcohol gives harmful effects, including the risk of developing alcohol-depending diseases and some types of cancers (29, 30, 31). Very high consumption can be fatal.

Based on ethanol content and substrates used in production process, most commonly consumed alcoholic beverages can be divided into:

Spirits: usually produced from grains, potatoes or sugar beets. To increase alcohol concentration they are distilled during the production. This process removes nutrients, leaving alcohol and water. Most common beverage of this group is vodka – usually contains 40% of alcohol, but concentration of ethanol can vary form 35% up to 70%.

Wine: originally made from the fermentation of grape juice, but also other fruit juice can be used to its production. Usually contains about 10% of alcohol, but concentration can differ around 9% to 15%. Wine contain only small amount of nutrients: sugars and minerals such as phosphorous, potassium, iron. Most important – wine, especially red one, contains high level of phenolic and polyphenolic compounds.

Beer: most commonly produced from barley usually with addition of hops, which gives characteristic bitter taste. It contains between 3–7% of alcohol with a typical alcohol by volume of 5%. Beer is a source of vitamins group B, including folates, also magnesium, potassium, phosphorous. Canned beer contains also vitamin C as a preservative.

Tea and coffee

Most common worldwide hot beverages are tea and coffee. In most countries consumption is polarized, one of them predominates. Taking into account infusion rate, three cups of tea are drunk for every one of coffee, and tea is preferred beverage in slightly more countries than coffee (32).

Coffee is cultivated in Latin America, Southeast Asia, and Africa; it comes from the evergreen bush of the species *Coffea,* with small berries containing coffee beans. To obtain infusion, mature berries must be picked, flesh removed leaving seeds, processed, dried, and then roasted, ground and brewed.

Term "tea" refers to the leaves and leaf buds of *Camellia* species, as well as beverage prepared from leaves. Production of tea usually involves several steps: withering, rolling, enzymatic oxidation ("fermentation"), drying. However, there are 5 most common kinds of tea, differed mostly by degree of fermentation.

Coffee and tea have no major nutritional value, contain only small amount of minerals, including potassium, phosphorus or magnesium (1). Far more important, however, is that they contain caffeine or theanine and other phenolic compounds, which have anticarcinogenic, anti-mutagenic and antioxidant properties (33, 34, 35, 36, 37).

Results

Alcohol

Overall consumption of alcohol drinks was higher among the cases (median: 0.50 drinks/week) than in the control group (0.06 drinks/week). Especially higher intake of beer portions was observed among cases (0.11 portions/week) in comparison with median intake of 0.00 portions/week in controls. The statistically significant difference between cases and controls was also observed in consumption of vodka – the median consumption in both groups was 0.00 portions per week, but higher dispersion was observed in colorectal cases (Table 7.11).

These results were confirmed in the analysis of pure alcohol intake in grams per week. Median consumption of pure alcohol per week in cases was 7.98 g/week in comparison with 0.92 g/week in control group and median intake of beer was 2.88 g of pure alcohol per week for cases and 0.00 g for controls. Less than 50% of respondents in both groups consumed vodka, but among the cases overall average intake of it was significantly higher (2.28 g of pure alcohol from vodka) than in the control group (1.83 g/week) – data about alcohol intake (expressed in grams of pure alcohol per week) are presented in Table 7.12.

Coffee and tee

Median consumption of coffee and tea was very similar in the study groups. For both, cases and controls median intakes were 7 portions of coffee and 14 portions of tee per week (Table 7.11). The same results were observed in consumption of coffee and tea expressed in grams per week (Table 7.12).

Table 7.11. Mean and median intakes of alcohol and non-alcoholic beverages for colorectal cancer cases and controls expressed in number of portions per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Alcohol – total	Mean	2.09	1.09	
[portions/week]	SD	4.57	2.81	0.001
	Median	0.50	0.06	
	(Q3–Q1)/2	1.06	0.50	
beer	Mean	1.62	0.71	
[portions/week]	SD	4.14	2.09	< 0.001
	Median	0.11	0.00	
	(Q3–Q1)/2	0.50	0.28	
wine	Mean	0.18	0.15	
[portions/week]	SD	0.66	0.56	0.885
	Median	0.00	0.00	
	(Q3–Q1)/2	2.50	2.50	
vodka	Mean	0.28	0.23	
[portions/week]	SD	0.76	1.57	< 0.001
	Median	0.00	0.00	
	(Q3–Q1)/2	0.11	0.03	
Coffee	Mean	7.98	8.86	
[portions/week]	SD	6.86	7.34	0.329
	Median	7.00	7.00	
	(Q3–Q1)/2	6.50	5.75	
Tea	Mean	15.19	16.09	
[portions/week]	SD	9.63	10.43	0.569
	Median	14.00	14.00	
	(Q3–Q1)/2	7.98	8.86	

Table 7.12. Mean and median intakes of alcohol and non-alcoholic beverages for colorectal cancer cases and controls – expressed in grams per week (2006–2008)

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
Alcohol – total	Mean	47.40	23.37	
[g/week]	SD	108.89	57.28	0.001
	Median	7.98	0.92	
	(Q3–Q1)/2	25.16	12.47	
beer	Mean	40.57	17.69	
[g/week]	SD	103.60	52.15	< 0.001
	Median	2.88	0.00	
	(Q3–Q1)/2	12.47	7.19	

Intakes		Cases N = 185	Controls N = 204	p value for Mann-Whitney test
wine	Mean	4.56	3.85	
[g/week]	SD	16.32	14.03	0.875
	Median	0.00	0.00	
	(Q3–Q1)/2	62.33	62.33	
vodka	Mean	2.28	1.83	
[g/week]	SD	6.06	12.60	< 0.001
	Median	0.00	0.00	
	(Q3–Q1)/2	0.92	0.22	
Coffee	Mean	1196.85	1329.57	
[g/week]	SD	1029.69	1101.86	0.329
	Median	1050.00	1050.00	
	(Q3–Q1)/2	975.21	863.03	
Tea	Mean	2279.56	2414.06	
[g/week]	SD	1444.33	1564.21	0.569
	Median	2100.00	2100.00	
	(Q3–Q1)/2	1313.24	1313.24	

Summary

- Cases consumed more portions of meat products than controls. Especially there were higher consumption of red meat and organ meats among cases. The analysis of weight confirmed that consumption of red meat and organ meat was higher in colorectal cancer patients.
- The consumption of eggs and egg-based products was higher among cases than in the control group.
- In this part of study we have not observed impact of cereals, fruits, vegetables, and dairy products on colorectal cancer prevalence.
- Alcohol consumption was higher among cases than in the control group. We have observed higher (and significant) intake of beer and vodka among cases.

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